SIP-adus Human Factors and HMI research (on-going project)

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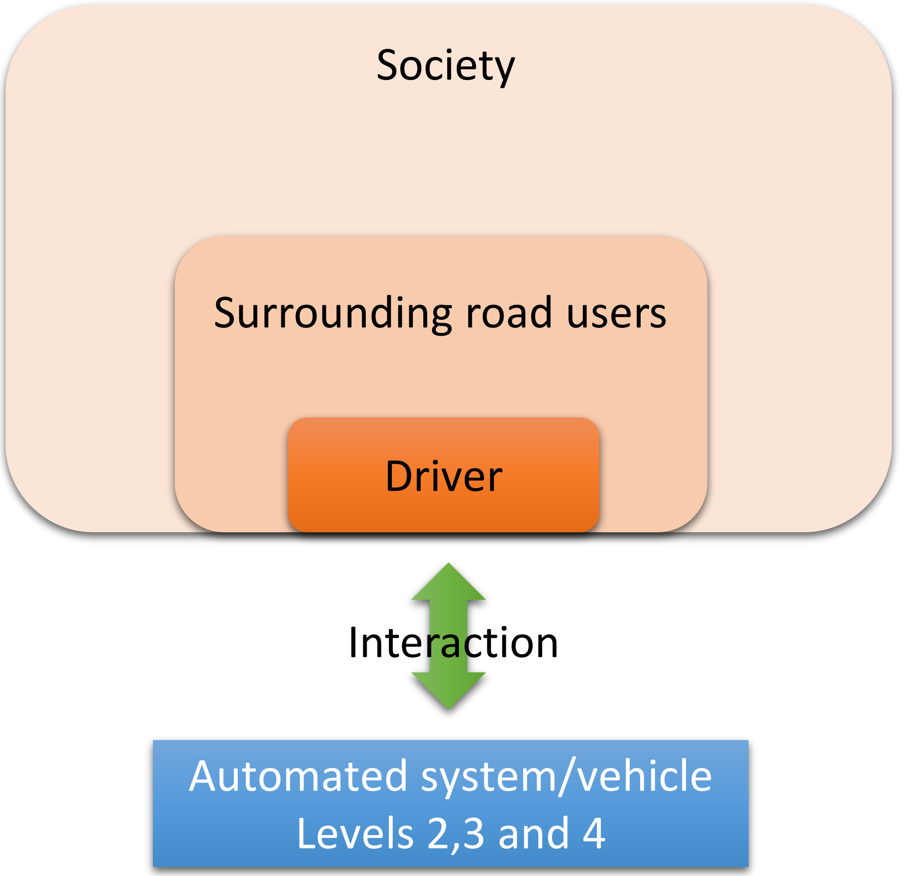
Framework for extraction of HF problems



Tasks with high priority

Task A (Driver-system interaction)

Task A investigates effects of system information (static and dynamic) on drivers' behavior in transition from Levels 2 and 3 to manual.

Task B (Driver-system interaction)

Task B investigates effects of driver state (readiness) with Levels 2 and 3 on his/her behavior in transition to manual.

Task C (AV-surrounding road user interaction)

Task C studies non-verbal communication between drivers and other road users, and investigates effective ways to functionalize the automated vehicle to be communicative.

Task A (3 years)

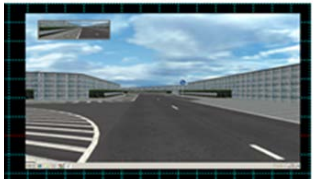
❑ Objectives

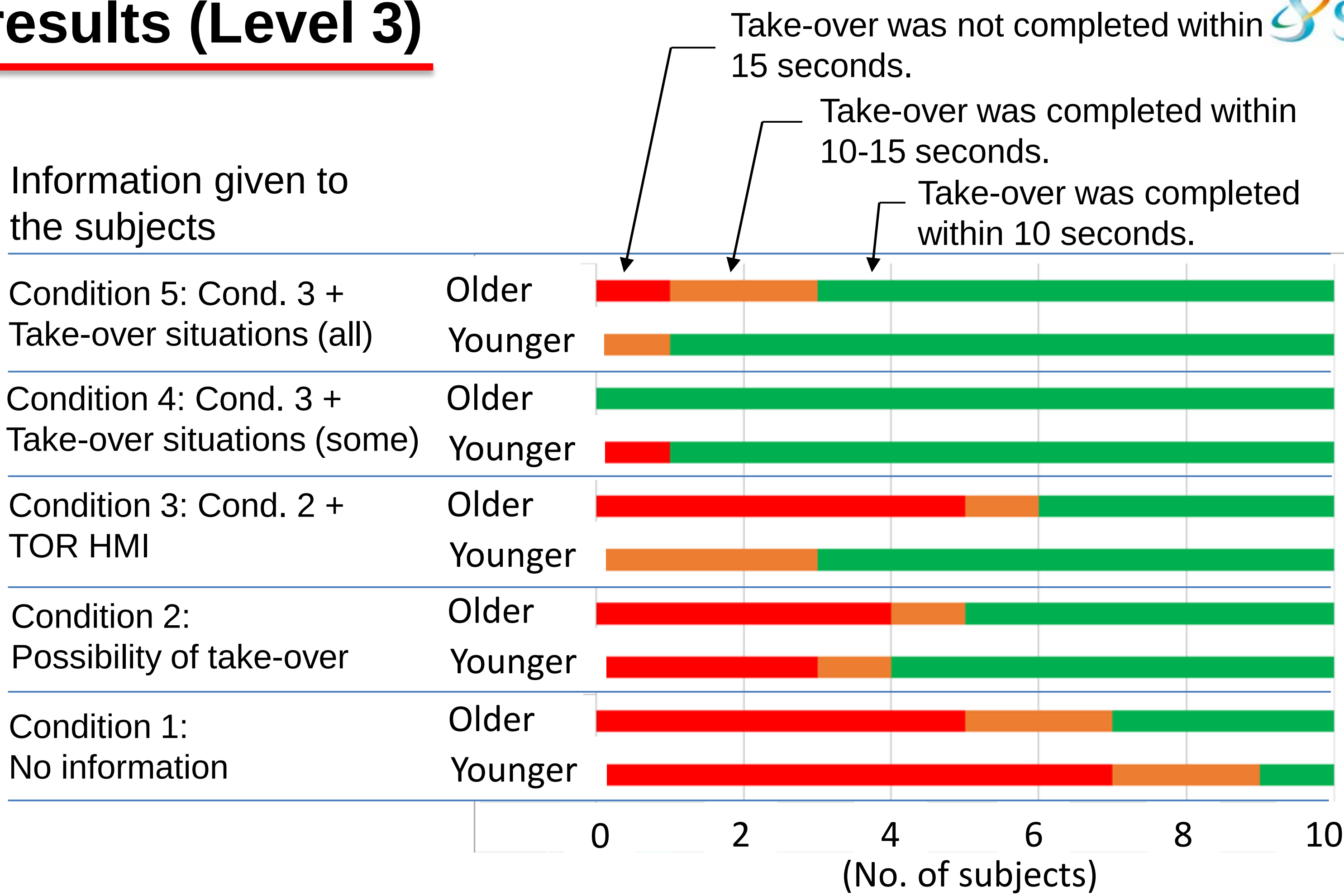
1. To investigate effects of static information of the system (knowledge) on drivers' behavior in transition from Levels 2 and 3 to manual. ← FY2016
2. To investigate effects of dynamic information of the system state on drivers' behavior in transition from Levels 2 and 3 to manual.
3. To identify fundamental requirements of the HMI displaying the dynamic information of the system state (prototyping included).

❑ Experimental method (FY2016)

Subjects receive various levels of information about functions and limitations of Level 2 and 3 systems before driving the systems in the driving simulator. Subjects' behavior in transition is analyzed as a function of the received information levels.

Example results (Level 3)



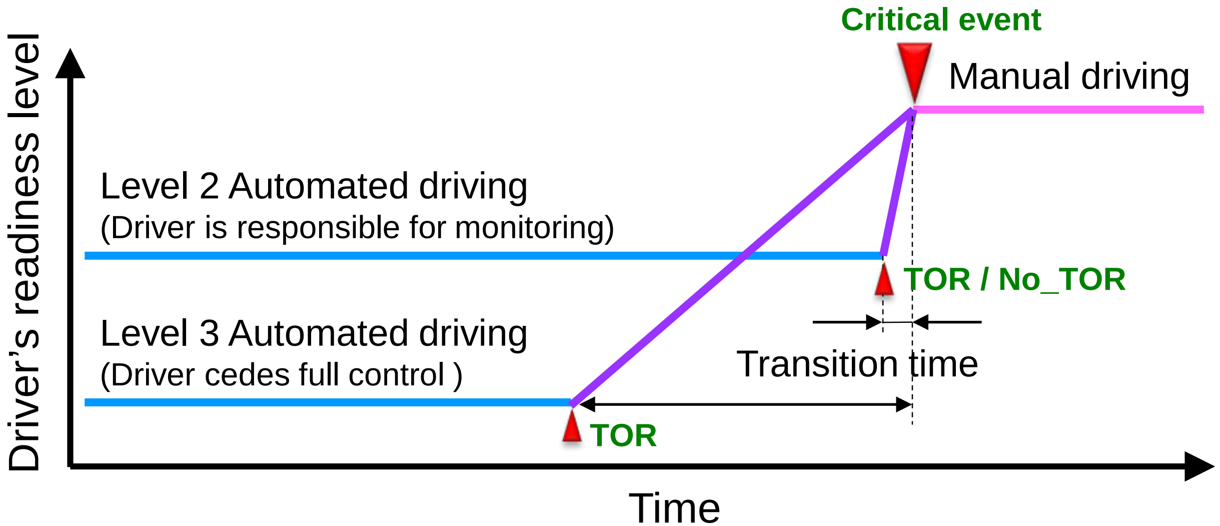


- Information about take-over situations is important (Cond. 1-3 vs Cond. 4,5).
- However, too much information about take-over situations degraded subjects' behavior especially for older subjects (Cond. 5).
- With no information, older subjects behaved slightly better than younger subjects. (Cond.1)

Task B (3 years)

❑ Objectives

1. To define driver's readiness with the system and identify fundamental requirements for the driver monitoring system. ← FY2016
2. To define the transition time as a function of readiness.
3. To identify fundamental requirements of the HMIs for supporting the driver to stay with the appropriate readiness and to take-over the driving task smoothly (prototyping included).



Driver's readiness and transition

❑ Experimental method (FY2016)

Subjects drive Level 2 and 3 systems with cognitive and physical secondary tasks in the driving simulator. The scenarios include several events with low criticality. Subjects' cognitive and physiological metrics are measured to extract those correlated with degraded performance in the events.

Driver state

- Cognitively distracted
- Physically distracted
- Low arousal
- Lack of SA
- Out of position

Controlled

Readiness

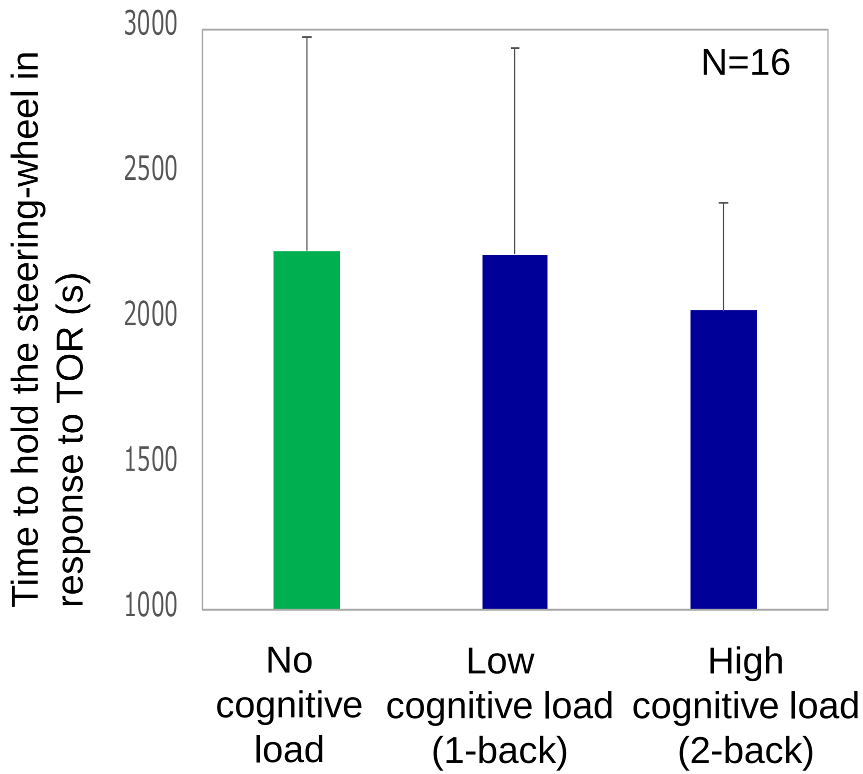
- Head orientation and visual performance
- Heart rate and blood pressure
- Body temperature
- Skin conductance
- EEG
- Posture and body movements

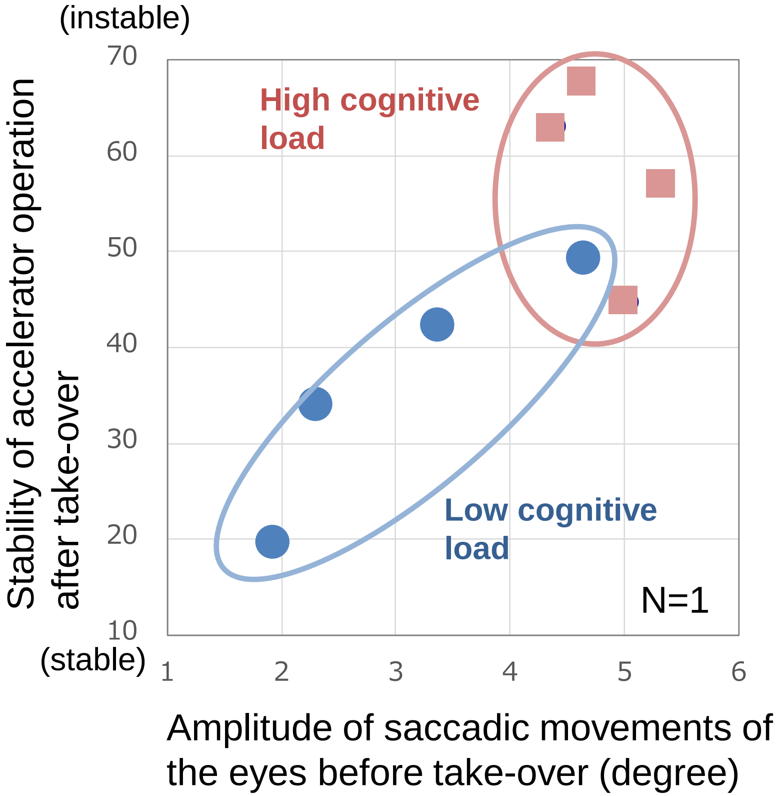
Performance at the event

- Longitudinal and lateral control of the vehicle
- Minimum distance and minimum TTC to the hazard
- Time spent to regain control

Correlation

Example results (Level 2)





- Cognitive loads given to the driver while driving with the Level 2 system did not produce significant differences in the time to hold the steering-wheel in response to TOR.
- However, cognitive loads seem to have deteriorated stability of driver's accelerator operation after take-over.
- Amplitude of the saccadic movements of driver's eyes seems to correlate with the deterioration (i.e. amplitude of the saccadic movements may be the driver state index).

Task C (3 years)

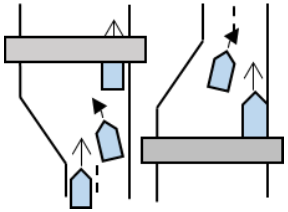
❑ Objectives

FY2016

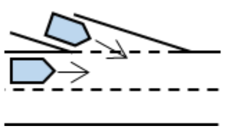
1. To study non-verbal communication between drivers and other road users.
2. To investigate the effect of ID display on behavior of surrounding road users.
3. To identify fundamental requirements for external HMIs and ID display for sending messages to surrounding road users (prototyping included).
4. To investigate effects of cultural differences on the communication (web or mail survey)

❑ Experimental method (FY2016)

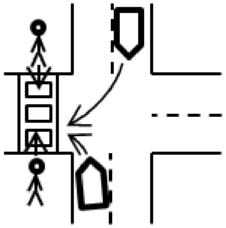
Communication behaviors between drivers and between driver and pedestrians are observed at fixed points and also in the car driven by the subject. Communication signals to pedestrians, including older adults and children, are also evaluated quantitatively in a closed field.



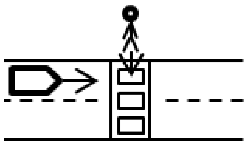
Around toll gates



Merging lane



Unsignalized intersection

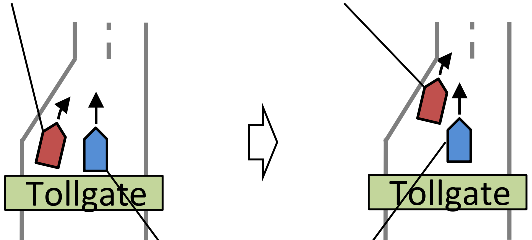


Unsignalized crosswalk

Examples of fixed point observation

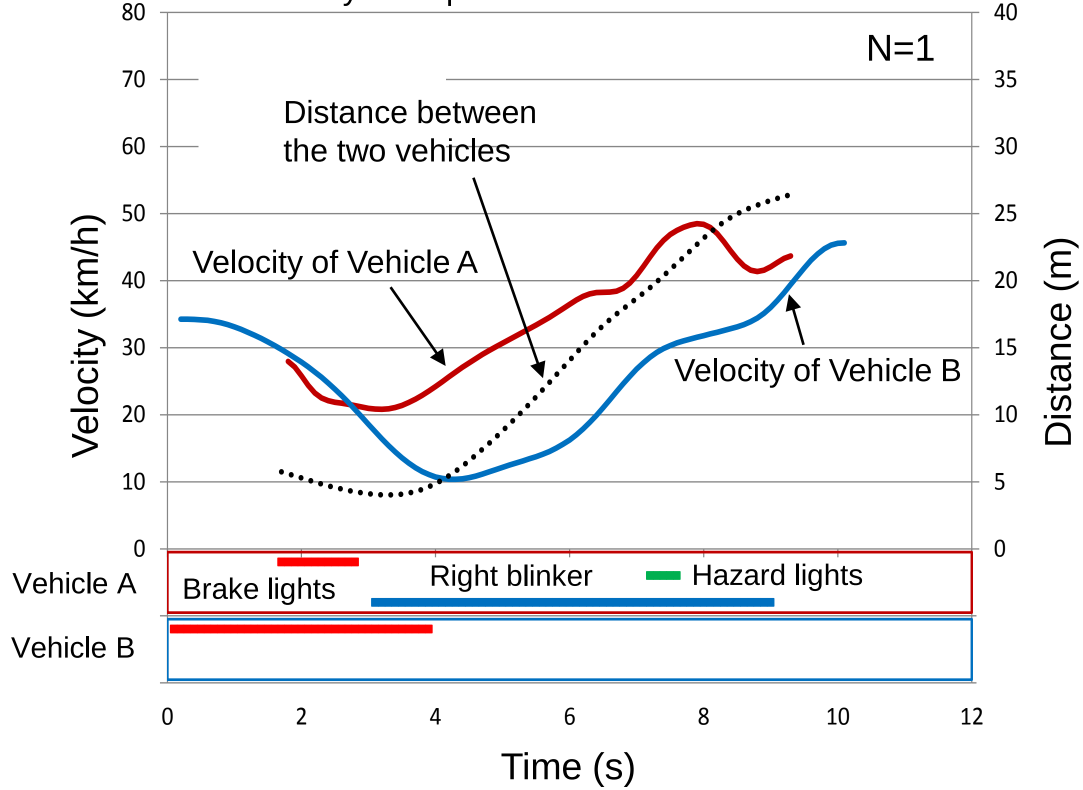
Example results (Fixed point observation)

A: Leading & merging vehicle



B: Following and yielding vehicle

❖ The data were quantified by processing video images obtained by fixed-point observation.



- The two vehicles A and B decelerated and came closer.
- The vehicle A tuned on the right blinker and waited for the vehicle B to decelerate more.
- The vehicle A merged into the lane and turned on the hazard lights.
- The data will be accumulated to quantify communicative behaviors in the relevant situations.

Conclusions

- SIP-adus Human Factors and HMI Research Project started in FY2016 with the support by the Cabinet Office. The project term is intended to be 3 years.
- The project includes;

  Task A: To investigate effects of system information on drivers' behavior in transition to manual.

  Task B: To investigate effects of driver state (readiness) with the system on his/her behavior in transition to manual.

  Task C: To investigate effective ways to functionalize AV to be communicative.
- Major outcomes will be shared after each fiscal year.

Appendix

Overview of potential HF problems / research questions

Interaction between vehicle and driver/surrounding road users/society			Level of automation (NHTSA, 2013) and research questions: Level 1	Level 2	Level 3	Level 4
Vehicle - Driver		Understanding of system				
	A-1	Understanding system functions	How to avoid over trust, over reliance, misunderstanding of functional limitations?			
	A-2	Understanding system states	How to avoid misunderstandings of system's current state and future actions?			
	A-3	Understanding system operations	How to improve usability of complicated HMI (switches)?			
	A-4	Understanding system behavior	How to avoid worries and discomfort for system's driving manner differing from driver's manner?			
		Driver's state				
	B-1	Driver state with automation		How to maintain required driver's state with automation?		
	B-2	Transition from automation to fully manual		How to avoid degraded response action of the driver unready to take over the vehicle control?		
	B-3	User benefits of automation		How to overcome the negative benefit of fight against drowsiness /boredom?	How to overcome the negative benefit of interruption of relax time?	How to compensate for the decreased value of homogenized car performance?
Vehicle - Surrounding road users	C-1	Communication between the automated vehicles and surrounding drivers		How to functionalize the automated vehicles to be communicative with other drivers at intersections, merging, lane change and others?		
	C-2	Communication between the automated vehicle and surrounding vulnerable road users		How to functionalize the automated vehicles to be communicative with pedestrians in crossroads, parkings, shared space and others?		
	C-3	Mediation between formal rules and traffic efficiency			How to mediate yielding with priority, difference between speed limit and traffic speed, and other conflicts?	
Vehicle - Society	D-1	Social value and acceptance of the automated vehicles			How to design functional deployment over time to raise social acceptance?	
	D-2	Liability			Who has the liability for crashes and legal violations caused by the system?	
	D-3	Licensing			Does licensing need to be changed for automated vehicles?	

A

B

C